



US009334484B2

(12) **United States Patent**  
**Dirr et al.**

(10) **Patent No.:** **US 9,334,484 B2**  
(45) **Date of Patent:** **\*May 10, 2016**

(54) **AUTOMATIC DETERGENT DISHWASHING COMPOSITION**

(56) **References Cited**

- (71) Applicant: **The Procter & Gamble Company**, Cincinnati, OH (US)
- (72) Inventors: **Penny Sue Dirr**, Crescent Springs, KY (US); **Corrine Nichol Case**, Cincinnati, OH (US); **Kathleen Anne Perry**, Walton, KY (US); **Pamala Gail Begley**, Fairfield, OH (US)
- (73) Assignee: **The Procter & Gamble Company**, Cincinnati, OH (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.  
This patent is subject to a terminal disclaimer.
- (21) Appl. No.: **14/832,132**
- (22) Filed: **Aug. 21, 2015**
- (65) **Prior Publication Data**  
US 2015/0353906 A1 Dec. 10, 2015

U.S. PATENT DOCUMENTS

4,105,827 A	8/1978	Brichard et al.	
4,246,612 A	1/1981	Berry et al.	
4,760,025 A	7/1988	Estell et al.	
4,765,916 A	8/1988	Ogar et al.	
4,810,410 A	3/1989	Diakun et al.	
4,972,017 A	11/1990	Smith et al.	
5,114,611 A	5/1992	Van Kralingen et al.	
5,227,084 A	7/1993	Martens et al.	
5,324,653 A	6/1994	Van Eekelen et al.	
5,453,216 A	9/1995	Kellett	
5,679,630 A	10/1997	Baeck et al.	
5,698,504 A	12/1997	Christie et al.	
5,766,371 A	6/1998	Bunch et al.	
5,856,164 A	1/1999	Outtrup et al.	
5,888,954 A	3/1999	Haerer et al.	
6,211,134 B1	4/2001	Caldwell et al.	
6,297,037 B1	10/2001	Barnett et al.	
6,312,936 B1	11/2001	Poulose et al.	
6,528,298 B1	3/2003	Svensden et al.	
6,670,314 B2	12/2003	Smith et al.	
6,995,125 B2	2/2006	Dasque et al.	
6,998,375 B2*	2/2006	Kapur	C11D 3/06 134/25.2
7,498,158 B2	3/2009	Svensden et al.	
7,521,411 B2	4/2009	Sharma et al.	
7,727,946 B2	6/2010	Catalfamo et al.	
8,008,241 B2*	8/2011	Souter	C11D 3/378 435/202
8,680,034 B2	3/2014	Souter	
8,980,814 B2	3/2015	Souter	
2002/0082186 A1	6/2002	Smith	

**Related U.S. Application Data**

- (63) Continuation of application No. 14/248,554, filed on Apr. 9, 2014, now Pat. No. 9,175,251, which is a continuation of application No. 12/397,515, filed on Mar. 4, 2009, now abandoned.
- (60) Provisional application No. 61/069,441, filed on Mar. 14, 2008, provisional application No. 61/192,480, filed on Sep. 18, 2008.
- (51) **Int. Cl.**  
**B08B 9/20** (2006.01)  
**C11D 3/386** (2006.01)  
**C12N 9/26** (2006.01)  
**C11D 3/395** (2006.01)  
**C11D 1/72** (2006.01)  
**C11D 3/37** (2006.01)  
**C11D 11/00** (2006.01)  
**C11D 17/00** (2006.01)  
**C11D 17/04** (2006.01)  
**C12N 9/28** (2006.01)

(Continued)

FOREIGN PATENT DOCUMENTS

DE	102004020082 A1	5/2005
WO	WO 94/02597 A1	2/1994
WO	WO 02/06438 A1	1/2002
WO	WO 02/02408 A2	5/2002
WO	WO 2005/121302 A1	12/2005

(Continued)

OTHER PUBLICATIONS

Branden et al., Introduction to Protein Structure, Garland Publishing Inc., New York, p. 247, 1991.

(Continued)

Primary Examiner — Bijan Ahvazi

(74) *Attorney, Agent, or Firm* — James F. McBride; Steven W. Miller

(57) **ABSTRACT**

An automatic dishwashing detergent composition in unit dose form wherein the composition comprises at least about 0.2 mg of active starch degrading enzyme per gram of composition and wherein the weight of the composition is less than about 25 grams.

- (52) **U.S. Cl.**  
CPC ..... **C12N 9/2414** (2013.01); **C11D 1/721** (2013.01); **C11D 3/378** (2013.01); **C11D 3/386** (2013.01); **C11D 3/38618** (2013.01); **C11D 3/3953** (2013.01); **C11D 11/0023** (2013.01); **C11D 17/0039** (2013.01); **C11D 17/0091** (2013.01); **C11D 17/045** (2013.01); **C12Y 302/01001** (2013.01)
- (58) **Field of Classification Search**  
USPC ..... 134/25.2, 25.3, 39, 40, 42; 435/202, 435/221; 510/220, 221, 224, 226, 227, 230, 510/232, 439, 441, 446, 514, 523  
See application file for complete search history.

**25 Claims, No Drawings**

(56)

References Cited

U.S. PATENT DOCUMENTS

2002/0137648 A1 9/2002 Sharma et al.  
 2002/0198125 A1 12/2002 Jones  
 2003/0171235 A1 9/2003 Hansen et al.  
 2004/0096952 A1 5/2004 Svendsen et al.  
 2004/0138078 A1 7/2004 Clare et al.  
 2004/0259749 A1 12/2004 Braeckman et al.  
 2005/0061703 A1\* 3/2005 Catlin ..... B65B 9/04  
 206/524.1  
 2005/0084937 A1 4/2005 Borchert et al.  
 2005/0170487 A1 8/2005 Svendsen et al.  
 2006/0035323 A2 2/2006 Bisgard et al.  
 2006/0090779 A1\* 5/2006 Sharma ..... A47L 15/44  
 134/146  
 2006/0097424 A1 5/2006 Sharma et al.  
 2006/0205628 A1 9/2006 Deinhammer et al.  
 2006/0234900 A1 10/2006 Olson et al.  
 2006/0257596 A1 11/2006 Catalfamo et al.  
 2007/0014815 A1 1/2007 Kroll et al.  
 2007/0179074 A1\* 8/2007 Souter ..... C12N 9/20  
 510/320  
 2008/0004201 A1 1/2008 Boutique et al.  
 2008/0014392 A1 1/2008 Ayats et al.  
 2008/0063774 A1 3/2008 Aehle et al.  
 2008/0193999 A1 8/2008 Andersen et al.  
 2008/0209863 A1 9/2008 Catlin et al.  
 2009/0233830 A1 9/2009 Dirr et al.  
 2009/0233832 A1 9/2009 Souter et al.  
 2014/0216503 A1\* 8/2014 Dirr ..... C11D 1/721  
 134/25.2  
 2015/0344823 A1 12/2015 Souter

FOREIGN PATENT DOCUMENTS

WO WO 2006/002643 A2 \* 1/2006  
 WO WO 2007/079938 A1 7/2007  
 WO WO 2007/079938 A2 7/2007  
 WO WO 2007/131656 A1 11/2007

WO WO 2007/131657 A3 11/2007  
 WO WO 2009/040544 A 2/2009

OTHER PUBLICATIONS

Seffernick et al., Melamine Deaminase and Atrazine Chlorohydrolase: 98 Percent Identical but Functionally Different, Journal of Bacteriology, Apr. 2001, 183(8):2405-2410.  
 Witkowski et al., Conversion of a  $\beta$ -Ketoacyl Synthase to a Malonyl Decarboxylase by Replacement of the Active-Site Cysteine with Glutamine, Biochemistry, 1999, 38:11643-11650.  
 "The detergent that lets customers save as they wash", Focus on Surfactants Elsevier, vol. 2007, No. 9, Sep. 1, 2007, pp. 5, XP022302950, ISSN:1351-4210.  
 Protease Novozymes Savinase, National Center for Biotechnology Education, University of Reading, <http://www.ncbe.reading.ac.uk/ncbe/materials/enzymes/savinase.html>, NCBE, 2011.  
 All Office Actions, U.S. Appl. No. 90/012,512, filed Sep. 12, 2012 with Office Actions dated Nov. 9, 2012; Sep. 6, 2013; Jul. 28, 2014 and Oct. 28, 2014.  
 All Office Actions, U.S. Appl. No. 12/397,489, filed Mar. 4, 2009 with Office Actions dated Sep. 16, 2010; Dec. 14, 2010 and Apr. 28, 2011.  
 All Office Actions, U.S. Appl. No. 13/189,610, filed Jul. 25, 2011 with Office Actions dated Apr. 25, 2012; Aug. 15, 2012; May 15, 2013; Oct. 29, 2013 and Jan. 30, 2014.  
 All Office Actions, U.S. Appl. No. 12/397,497, filed Mar. 4, 2009 with Office Actions dated Aug. 17, 2011; Apr. 20, 2012; May 9, 2012 and Nov. 15, 2012.  
 International Search Report; International Application No. PCT/IB2009/050946; date of mailing Jun. 25, 2009.  
 WO 2007/079938 A3; Amended Claims, Jul. 19, 2007, Henkel Kommanditgesellschaft Auf Aktien.  
 WO 2007/079938 A3; Search Report, Jul. 19, 2007, Henkel Kommanditgesellschaft Auf Aktien.

\* cited by examiner

1

## AUTOMATIC DETERGENT DISHWASHING COMPOSITION

### TECHNICAL FIELD

The present invention is in the field of detergents. In particular, it relates to an automatic dishwashing detergent composition in unit dose form. More particularly, to an automatic dishwashing composition in unit dose form comprising a high level of starch degrading enzyme, preferably in combination with a protease. The composition prevents grit formation during the automatic dishwashing process and provides excellent cleaning and finishing benefits.

### BACKGROUND

A frequent problem found in automatic dishwashing is the presence of grit on washed items. Grit is sometimes found on dishware/tableware after the automatic dishwashing process even if the items were free of it before they went into the dishwasher. It seems that grit is formed during the dishwashing process. Grit seems to negatively impact on shine. The mechanism by which grit is formed is not well understood. It maybe due to the high temperatures and combination of different soils lifted from the soiled items during the dishwashing process. Somehow, the different soils seem to recombine to give rise to grit which deposits onto the surface of the washed items. Once the grit is formed and deposited onto the surfaces of the washed items it is very difficult to remove it. The problem seems to be more acute in the case of detergents in unit dose form and in the case of heavily soiled loads.

In view of the above discussion, an objective of the present invention is to provide a product in unit dose form capable of preventing grit formation in automatic dishwashing.

### SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided an automatic dishwashing detergent composition in unit dose form comprising a high level of active starch degrading enzyme. Any starch degrading detergent enzyme can be used in the composition of the invention. A good performance in terms of grit prevention has been found when using an alpha-amylase. The composition of the invention comprises at least 0.2 mg of active starch degrading enzyme per gram of composition, preferably from about 0.2 to about 10, more preferably from about 0.25 to about 6, especially from about 0.3 to about 4 mg of active starch degrading enzyme per gram of composition. It has been found that unit dose products comprising a high level of starch degrading enzyme help to prevent grit formation during the automatic dishwashing process and provide good cleaning and finishing results. The results can be further improved by adding a protease enzyme to the composition, preferably a high level of protease. In preferred embodiments, the composition comprises a high level of protease, in particular at least 1.5 mg of active protease per gram of composition. Preferred levels of protease in the compositions of the invention include from about 1.5 to about 10, more preferably from about 1.8 to about 5 and especially from about 2 to about 4 mg of active protease per grams of composition. The compositions of the invention are good from a biodegradability stand point. The high level of enzyme allows for a reduction on the level of non-biodegradable ingredients of the product and at the same time improves cleaning and finishing performance.

In preferred embodiments, the composition comprises two different proteases with different temperature profiles. By

2

“different temperature profile” is meant that there is a low and a high temperature protease. The low temperature protease demonstrates at least 1.2, preferably at least 1.5 and more preferably at least 2 times the relative activity of the reference protease at 25° C. As used herein, the “reference protease” is the wild-type subtilisin protease of *Bacillus lentus*, commercially available under the tradenames of Savinase™ or Purafect™ and whose sequence can be found as SEQ ID No:4. As used herein, “relative activity” is the fraction derived from dividing the activity of the enzyme at the temperature assayed versus its activity at its optimal temperature measured at a pH of 9.

Many automatic dishwashing machines have a main-wash cold fill. The water gets heated up in the dishwasher until it reaches the wash temperature. Many of the proteases are designed to present maximum activity once the water reaches the wash temperature. In these cases the first part of the wash cycle can be underused. It has been found that better use of the wash cycle can be made by having a mixture of proteases with different temperature profile. This mixture of proteases can be beneficial even when the dishwasher is filled with hot water because the water temperature can change with time.

Better results in terms of grit removal can be achieved when the composition comprises a lipase, thus in a preferred embodiment the composition of the invention comprise a lipase, preferably a lipase derived from the *Humicola Lanuginosa* wild-type that contains the mutations T231R and N233R. Compositions comprising Lipex® (Novozymes A/S, Bagsvaerd, Denmark) have been found particularly effective in terms of grit prevention.

In especially preferred embodiments, the composition comprises an anti-redeposition agent and/or sulfonated polymer. Excellent finishing results are obtained with compositions comprising an anti-redeposition agent or a sulfonated polymer and in particular compositions comprising a combination thereof. Benefits are seen in terms of reduction/prevention of filming, spotting and improvement on shine. Shine on washed items seem to be an unsolved problem, in particular in stressed cases of highly soiled loads. The compositions of the invention provide shine benefits even under stressed conditions. These benefits, under stressed conditions, are not easily achievable with compositions lacking the high level of enzymes of the present invention.

In preferred embodiments, the compositions of the invention reduce the particle size of the soil fragments and/or molecular weight as compared to that obtained with traditional detergent compositions. This facilitates the suspension of the soils in the wash liquor. Soil suspension can further be improved by an anti-redeposition agent. The anti-redeposition agent contributes to keep detached soils as individual entities in solution and prevents re-combination that can give rise to grit formation. These agents can also help to detach soils from the soiled surfaces. This in combination with soil suspension contributes to a more effective enzymatic cleaning and results in better shine and reduced filming and spotting on the washed items. Preferred anti-redeposition agents are non-ionic surfactants, in particular non-ionic surfactants having a phase inversion temperature (PIT) in the range of from about 40 to about 70° C. Compositions comprising non-ionic surfactants having a PIT in this temperature range provide very good cleaning. The anti-redeposition agent may also help the enzymes to get to the soiled substrates. The anti-redeposition agent seems to help with the cleaning during the main wash. Some of the anti-redeposition agent is carried over to the rinse cycle where it helps with sheeting thereby reducing/eliminating filming and spotting. Surfactants, having a PIT in the claimed range, present cleaning

properties during the main wash and sheeting properties during the rinse. In other preferred embodiments the anti-redeposition agent is a non-ionic surfactant having a Draves wetting time (as measured using the standard method ISO 8022 under the following conditions; 3-g hook, 5-g cotton skein, 0.1% by weight aqueous solution at a temperature of 25° C.) of less than about 360 seconds, preferably less than 60 seconds.

It is also preferred that the compositions of the invention comprise a metal care agent, in particular a zinc salt.

Products in unit dose form include tablets, capsules, sachets, pouches, etc. Preferred for use herein are tablets, tablets wrapped with a water-soluble film and water-soluble pouches. The weight of the composition of the invention is from about 10 to about 25 grams, preferably from about 12 to about 24 grams and more preferably from 14 to 22 grams. These weights are extremely convenient for automatic dishwashing product dispenser fit reasons. In the cases of unit dose products having a water-soluble material enveloping the detergent composition, the water-soluble material is not considered as part of the composition.

In preferred embodiments the unit dose form is a water-soluble pouch (i.e., water-soluble film enveloping a detergent composition), preferably a multi-compartment pouch having a plurality of films forming a plurality of compartments. This contributes to the flexibility and optimization of the composition. It allows for the separation and controlled release of different ingredients. Preferably one compartment contains a composition in solid form and another compartment contains a composition in liquid form.

In preferred multi-compartment pouch embodiments two different compartments contain anti-redeposition agent. Preferably the films of these two compartments have different dissolution profiles, allowing the release of anti-redeposition agents at different times. For example, anti-redeposition agent from one compartment (first compartment) can be delivered early in the washing process to help with soil removal and anti-redeposition agent from another compartment (second compartment) can be delivered at least two minutes, preferably at least five minutes later than the anti-redeposition agent from the first compartment. Ideally, the enzymes should be delivered after the anti-redeposition agent from the first compartment and before the anti-redeposition agent from the second compartment.

Especially preferred for use herein is a multi-compartment pouch comprising two side-by-side compartments superposed onto another compartment wherein at least two different compartments contain two different compositions.

According to the second aspect of the invention, there is provided a method of dishwashing in an automatic dishwashing machine using the detergent composition of the invention and comprising the steps of placing the composition into the product dispenser and releasing it during the main-wash cycle.

In preferred process embodiments, anti-redeposition agents are delivered at two different points in times of the dishwashing process.

According to the third aspect of the invention, there is provided the use of the detergent composition of the invention to prevent grit formation in automatic dishwashing.

### DETAILED DESCRIPTION OF THE INVENTION

The present invention envisages an automatic dishwashing detergent composition in unit dose form (i.e., an automatic dishwashing detergent unit dose product). The composition comprises a high level of starch degrading enzyme, prefer-

ably in combination with high level of protease enzyme and more preferably in combination with a lipase enzyme. The compositions of the invention prevent grit formation on washed items, which is one of the problems currently found in automatic dishwashing. The composition provides excellent cleaning and finishing results. The present invention also envisages a method of dishwashing using compositions in unit dose form comprising a high level of starch degrading enzyme, preferably in combination with high level of protease enzyme.

#### Enzyme Related Terminology

#### Nomenclature for Amino Acid Modifications

In describing enzyme variants herein, the following nomenclature is used for ease of reference: Original amino acid(s):position(s):substituted amino acid(s).

According to this nomenclature, for instance the substitution of glutamic acid for glycine in position 195 is shown as G195E. A deletion of glycine in the same position is shown as G195\*, and insertion of an additional amino acid residue such as lysine is shown as G195GK. Where a specific enzyme contains a "deletion" in comparison with other enzyme and an insertion is made in such a position this is indicated as \*36D for insertion of an aspartic acid in position 36. Multiple mutations are separated by pluses, i.e.: S99G+V102N, representing mutations in positions 99 and 102 substituting serine and valine for glycine and asparagine, respectively. Where the amino acid in a position (e.g. 102) may be substituted by another amino acid selected from a group of amino acids, e.g. the group consisting of N and I, this will be indicated by V102N/I.

In all cases, the accepted IUPAC single letter or triple letter amino acid abbreviation is employed.

#### Protease Amino Acid Numbering

The numbering used in this patent is numbering versus the specific protease (PB92) listed as SEQ ID No:1. An alternative numbering scheme is the so-called BPN' numbering scheme which is commonly used in the art. For convenience the numbering schemes are compared below in Table 1:

TABLE 1

Protease Mutation numbering	
PB92 numbering of this patent (numbering versus SEQ ID NO: 1)	Equivalent BPN' numbering
G116V + S126L + P127Q + S128A	G118V + S128L + P129Q + S130A
G116V + S126N + P127S + S128A + S160D	G118V + S128N + P129S + S130A + S166D
G116V + S126L + P127Q + S128A + S160D	G118V + S128L + P129Q + S130A + S166D
G116V + S126V + P127E + S128K	G118V + S128V + P129E + S130K
G116V + S126V + P127M + S160D	G118V + S128V + P129M + S166D
S128T	S130T
G116V + S126F + P127L + S128T	G118V + S128F + P129L + S130T
G116V + S126L + P127N + S128V	G118V + S128L + P129N + S130V
G116V + S126F + P127Q	G118V + S128F + P129Q
G116V + S126V + P127E + S128K + S160D	G118V + S128V + P129E + S130K + S166D
G116V + S126R + P127S + S128P	G118V + S128R + P129S + S130P
S126R + P127Q + S128D	S126R + P129Q + S130D
S126C + P127R + S128D	S128LC + P129R + S130D
S126C + P127R + S128G	S128LC + P129R + S130G

## Amino Acid Identity

The relatedness between two amino acid sequences is described by the parameter "identity". For purposes of the present invention, the alignment of two amino acid sequences is determined by using the Needle program from the EMBOSS package (<http://emboss.org>) version 2.8.0. The Needle program implements the global alignment algorithm described in Needleman, S. B. and Wunsch, C. D. (1970) J. Mol. Biol. 48, 443-453. The substitution matrix used is BLO-SUM62, gap opening penalty is 10, and gap extension penalty is 0.5.

The degree of identity between an amino acid sequence of and enzyme used herein ("invention sequence") and a different amino acid sequence ("foreign sequence") is calculated as the number of exact matches in an alignment of the two sequences, divided by the length of the "invention sequence" or the length of the "foreign sequence", whichever is the shortest. The result is expressed in percent identity. An exact match occurs when the "invention sequence" and the "foreign sequence" have identical amino acid residues in the same positions of the overlap. The length of a sequence is the number of amino acid residues in the sequence.

## Alpha-Amylase

Suitable alpha-amylases for use herein include those of bacterial or fungal origin. Chemically or genetically modified mutants (variants) are included. A preferred alkaline alpha-amylase is derived from a strain of *Bacillus*, such as *Bacillus licheniformis*, *Bacillus amyloliquefaciens*, *Bacillus stearothermophilus*, *Bacillus subtilis*, or other *Bacillus* sp., such as *Bacillus* sp. NCIB 12289, NCIB 12512, NCIB 12513, DSM 9375 (U.S. Pat. No. 7,153,818) DSM 12368, DSMZ no. 12649, KSM AP1378 (WO 97/00324), *Bacillus* sp. 707, KSM K36 or KSM K38 (EP 1,022,334). Preferred amylases include:

(a) the variants described in WO 94/02597, WO 94/18314, WO96/23874 and WO 97/43424, especially the variants with substitutions in one or more of the following positions versus the enzyme listed as SEQ ID No. 2 in WO 96/23874: 15, 23, 105, 106, 124, 128, 133, 154, 156, 181, 188, 190, 197, 202, 208, 209, 243, 264, 304, 305, 391, 408, and 444.

(b) the variants described in U.S. Pat. No. 5,856,164 and WO99/23211, WO 96/23873, WO00/60060 and WO 06/002643, especially the variants with one or more substitutions in the following positions versus the AA560 enzyme listed as SEQ ID No. 2:

9, 26, 30, 33, 82, 37, 106, 118, 128, 133, 149, 150, 160, 178, 182, 186, 193, 195, 202, 203, 214, 231, 256, 257, 258, 269, 270, 272, 283, 295, 296, 298, 299, 303, 304, 305, 311, 314, 315, 318, 319, 320, 323, 339, 345, 361, 378, 383, 419, 421, 437, 441, 444, 445, 446, 447, 450, 458, 461, 471, 482, 484 that also preferably contain the deletions of D183\* and G184.

(c) variants exhibiting at least 90% identity with SEQ ID No. 4 in WO06/002643, the wild-type enzyme from *Bacillus* SP722, especially variants with deletions in the 183 and 184 positions and variants described in WO 00/60060, which is incorporated herein by reference.

(d) variants exhibiting at least 95% identity with SEQ ID NO:5, the wild-type enzyme from *Bacillus* sp.707, especially those comprising mutations in one or more of the following positions M202, M208, S255, R172, and/or M261.

Suitable commercially available alpha-amylases are DURAMYL®, LIQUEZYME®, TERMAMYL®, TERMAMYL ULTRA®, NATALASE®, SUPRAMYL®, STAINZYME®, STAINZYME PLUS®, FUNGAMYL® and BAN® (Novozymes A/S), BIOAMYLASE-D(G), BIO-

AMYLASE® L (Biocon India Ltd.), KEMZYM® AT 9000 (Biorzym Ges. m.b.H, Austria), RAPIDASE®, PURASTAR®, OPTISIZE HT PLUS® and PURASTAR OXAM® (Genencor International Inc.) and KAM® (KAO, Japan). In one aspect, preferred amylases are NATALASE®, STAINZYME® and STAINZYME PLUS® and mixtures thereof.

Preferred amylases for use herein are low temperature amylases. Compositions comprising low temperature amylases allow for a more energy efficient dishwashing processes without compromising in cleaning. Also preferred for use herein is a combination of a mixture of two or more amylases, preferably the mixture comprises at least one low temperature amylase. A mixture of amylases can contribute to an enhanced cleaning across a broader temperature and/or substrate range and provide superior shine benefits, especially when used in conjunction with an anti-redeposition agent and/or a sulfonated polymer.

As used herein, "low temperature amylases" are amylases that demonstrate at least 1.2, preferably at least 1.5 and more preferably at least 2 times the relative activity of the reference amylase at 25° C. As used herein, the "reference amylase" is commercially available under the tradename of Termamyl™ (Novozymes A/S), the enzyme of SEQ ID No.3. As used herein, "relative activity" is the fraction derived from dividing the activity of the enzyme at the temperature assayed versus its activity at its optimal temperature measured at a pH of 9.

Preferably low temperature amylases possess one or more of the following properties:

(a) greater than or equal to 60%, preferably 70%, more preferably 80% and especially 90% of their maximum activity at 50° C.

(b) greater than or equal to 30%, preferably 40%, more preferably 50%, even more preferably 60% and especially 70% of their maximum activity at 40° C.

(c) greater than or equal to 20%, preferably 30% more preferably 40% of their maximum activity at 30° C.

Activity may be determined by well-known standard amylase assays described herein below and is assayed between 20 and 90° C.

Low temperature amylases for use herein, including chemically or genetically modified mutants (variants), are alkaline amylases possessing at least 90%, preferably 95%, more preferably 98%, even more preferably 99% and especially 100% identity, with those derived from *Bacillus* sp. NCIB 12289, NCIB 12512, NCIB 12513, DSM 9375 (U.S. Pat. No. 7,153,818) DSM 12368, DSMZ no. 12649, KSM AP1378 (WO 97/00324), KSM K36 or KSM K38 (EP 1,022, 334). Preferred low temperature amylases include:

(a) the variants described in U.S. Pat. No. 5,856,164 and WO99/23211, WO 96/23873, WO00/60060 and WO 06/002643, especially the variants with one or more substitutions in the following positions versus the AA560 enzyme listed as SEQ ID NO:2:

9, 26, 30, 33, 82, 37, 106, 118, 128, 133, 149, 150, 160, 178, 182, 186, 193, 195, 202, 203, 214, 231, 256, 257, 258, 269, 270, 272, 283, 295, 296, 298, 299, 303, 304, 305, 311, 314, 315, 318, 319, 320, 323, 339, 345, 361, 378, 383, 419, 421, 437, 441, 444, 445, 446, 447, 450, 458, 461, 471, 482, 484 that also preferably contain the deletions of D183\* and G184\*.

(b) variants exhibiting at least 90% identity with SEQ ID No. 4 in WO06/002643, the wild-type enzyme from *Bacillus* SP722, especially variants with deletions in the 183 and 184 positions and variants described in WO 00/60060, which is incorporated herein by reference. Suitable commercially available low temperature alpha-

7

amylases include STAINZYME®, STAINZYME PLUS®, STAINZYME ULTRA® and NATALASE® (Novozymes A/S).

- (c) variants exhibiting at least 95% identity with SEQ ID NO:5, the wild-type enzyme from *Bacillus* sp.707, especially those comprising mutations in one or more of the following positions M202, M208, S255, R172, and/or M261.

Especially preferred low temperature amylase for use herein is an amylase variant comprising either:

- (a) one or more, preferably three or more substitutions in the following positions versus SEQ ID NO: 2: 9, 26, 149, 182, 186, 202, 257, 295, 299, 323, 339 and 345; and
- (b) optionally with one or more, preferably all of the substitutions and/or deletions in the following positions: 118, 183, 184, 195, 320 and 458, which if present preferably comprise R118K, D183\*, G184\*, N195F, R320K and/or R458K.

or:

- (c) at least one substitution in the following positions versus SEQ ID NO:5: M202, M208, S255, R172, and/or M261. Preferably said amylase comprises one or more of M202L, M202V, M202S, M202T, M202I, M202Q, M202W, S255N and/or R172Q. Particularly preferred are those comprising the M202L or M202T mutations.

Most preferred low temperature amylases include those comprising the following sets of mutations:

- (i) M9L+M323T;
- (ii) M9L+M202L/T/V/I+M323T;
- (iii) M9L+N195F+M202L/T/V/I+M323T;
- (iv) M9L+R118K+D183\*+G184\*+R320K+M323T+R458K;
- (v) M9L+R118K+D183\*+G184\*+M202L/T/V/I+R320K+M323T+R458K;
- (vi) M9L+G149A+G182T+G186A+M202L+T257I+Y295F+N299Y+M323T+A339S+E345R;
- (vii) M9L+G149A+G182T+G186A+M202I+T257I+Y295F+N299Y+M323T+A339S+E345R;
- (viii) M9L+R118K+G149A+G182T+D183\*+G184\*+G186A+M202L+T257I+Y295F+N299Y+R320K+M323T+A339S+E345R+R458K;
- (ix) M9L+R118K+G149A+G182T+D183\*+G184\*+G186A+N195F+M202L+T257I+Y295F+N299Y+R320K+M323T+A339S+E345R+R458K;
- (x) M9L+R118K+G149A+G182T+D183\*+G184\*+G186A+M202I+T257I+Y295F+N299Y+R320K+M323T+A339S+E345R+R458K;
- (xi) M9L+R118K+D183\*+D184\*+N195F+M202L+R320K+M323T+R458K;
- (xii) M9L+R118K+D183\*+D184\*+N195F+M202T+R320K+M323T+R458K;
- (xiii) M9L+R118K+D183\*+D184\*+N195F+M202I+R320K+M323T+R458K;
- (xiv) M9L+R118K+D183\*+D184\*+N195F+M202V+R320K+M323T+R458K;
- (xv) M9L+R118K+N150H+D183\*+D184\*+N195F+M202L+V214T+R320K+M323T+R458K; or
- (xvi) M9L+R118K+D183\*+D184\*+N195F+M202L+V214T+R320K+M323T+E345N+R458K.

The amylase sold under the tradename STAINZYME PLUS® is the most preferred.

A high temperature amylase is characterized in that it has a relative activity of less than 0.25 or typically less than 0.2 at a pH of 9 and a temperature of 25° C. An example of such an enzyme would be the reference enzyme of this test, Ter-

8

mamyI™, the wild-type enzyme from *Bacillus licheniformis*, whose sequence is SEQ ID No:3.

Assay for Alpha-Amylase Activity

Amylase activity is measured using a maltoheptaoside modified with a p-Nitrophenol chromophore (Infinity Amylase Reagent from Thermo Electron, Woburn, Mass., USA, Cat #: TR25421). Release of the chromophore is initiated via amylase action. Amylase activity is measured initially in AMU's. 1 AMU (amylase unit) is the amount of enzyme which hydrolyzes PNP-G7 (p-nitrophenyl-alpha,D-maltoheptaoside) carbohydrate substrate such that the initial rate of formation of small carbohydrates (G2-4) per minute corresponds to 1 μmole of 4-Nitrophenol per minute.

The test is run versus a reference enzyme, that of SEQ ID No:3 sold under the tradename TermamyI™ (Novozymes A/S). These amylase units (AMUs) are converted into a unit of KNU, using the conversion factor 0.133 mg of TermamyI™ corresponds to 1 KNU. Therefore if using the above assay the enzyme sample shows an activity equivalent to that shown by 0.266 mg of TermamyI™, its activity is considered to be 2 KNU.

Analysis

200 μL of dilute enzyme containing sample is added to 2500 μL of Infinity amylase reagent. Mix and incubate at 37° C. for 4.5 minutes. The absorbance is read at 415 nm.

Preferably, the low temperature amylase in the composition of the invention has an activity of at least 6 KNU, more preferably at least 7.5 KNU per gram of detergent composition.

30 Protease

Suitable proteases include metalloproteases and serine proteases, including neutral or alkaline microbial serine proteases, such as subtilisins (EC 3.4.21.62). Suitable proteases include those of animal, vegetable or microbial origin. Microbial origin is preferred. Chemically or genetically modified mutants are included. The protease may be a serine protease, preferably an alkaline microbial protease or a chymotrypsin or trypsin-like protease. Examples of neutral or alkaline proteases include:

- (a) subtilisins (EC 3.4.21.62), including those derived from *Bacillus*, such as *Bacillus lentus*, *B. alkalophilus*, *B. subtilis*, *B. amyloliquefaciens*, *Bacillus pumilus* and *Bacillus gibsonii* described in U.S. Pat. No. 6,312,936 B1, U.S. Pat. No. 5,679,630, U.S. Pat. No. 4,760,025, DE102006022216A1 and DE102006022224A1.
- (b) trypsin-type or chymotrypsin-type proteases, such as trypsin (e.g., of porcine or bovine origin), including the *Fusarium* protease described in WO 89/06270 and the chymotrypsin proteases derived from *Cellulomonas* described in WO 05/052161 and WO 05/052146.
- (c) metalloproteases, including those derived from *Bacillus amyloliquefaciens* described in WO 07/044993A2.

Suitable commercially available protease enzymes include those sold under the trade names Alcalase®, Savinase®, Primase®, Durazym®, Polarzyme®, Kannase®, Liquezyme®, Ovozyme®, Neutrase®, Everlase® and Esperase® by Novozymes A/S (Denmark), those sold under the tradename Maxatase®, Maxacal®, Maxapem®, Properase®, Purafect®, Purafect Prime®, Purafect Ox®, FN3®, FN4® and Purafect OXP® by Genencor International, and those sold under the tradename Opticlean® and Optimase® by Solvay Enzymes.

In the composition of the invention a mixture of two or more proteases may be used, such mixtures comprising at least one low temperature protease are preferred for use herein. A mixture of proteases can contribute to an enhanced cleaning across a broader temperature and/or substrate range

and provide superior shine benefits, especially when used in conjunction with an anti-redeposition agent and/or a sulfonated polymer.

#### Low-Temperature Protease

Proteases commonly used in detergents are highly effective at high temperatures of 50° C. and in particular 60° C. One such commonly used protease is the wild-type subtilisin protease of *Bacillus lentus*, sold under the tradenames of Savinase™ or Purafect™ and described below as the reference protease.

It has been found that it can be particularly advantageous for one or more of the proteases present in the composition of the invention to be a low temperature protease. As used herein, "low temperature protease" is a protease that demonstrates at least 1.2, preferably at least 1.5 and more preferably at least 2 times the relative activity of the reference protease at 25° C. As used herein, the "reference protease" is the wild-type subtilisin protease of *Bacillus lentus*, commercially available under the tradenames of Savinase™ M or Purafect™ and whose sequence is SEQ ID No:4. As used herein, "relative activity" is the fraction derived from dividing the activity of the enzyme at the temperature assayed versus its activity at its optimal temperature measured at a pH of 9.

Low temperature proteases for use herein include polypeptides demonstrating at least 90%, preferably at least 95%, more preferably at least 98%, even more preferably at least 99% and especially 100% identity with the wild-type enzyme from *Bacillus lentus*, comprising mutations in one or more, preferably two or more and more preferably three or more of the following positions, using the BPN' numbering system and amino acid abbreviations as illustrated in WO00/37627, which is incorporated herein by reference:

68, 87, 99, 101, 103, 104, 118, 128, 129, 130, 167, 170, 194, 205 & 222

Preferably, the mutations are selected from one or more, preferably two or more and more preferably three or more of the following: V68A, S87N, S99D, S101, S103A, V104N/I, Y167A, R170S, A194P, V205I and/or M222S.

If compared directly to the enzyme of SEQ ID NO:4, the above sets of mutations correspond to mutations in the following positions:

66, 85, 97, 99, 101, 102, 116, 126, 127, 128, 161, 164, 188, 199 & 216

Preferably, the mutations are selected from one or more, preferably two or more and more preferably three or more of the following versus the enzyme of SEQ ID NO:4:

V66A, S85N, S97D, S99G, S101A, V102N/I, Y161A, R164S, A188P, V199I and/or M216S.

Most preferably the protease is selected from the group comprising the below mutations versus SEQ ID NO:1 (mutation numbering is directly versus SEQ ID NO:1, rather than the BPN' numbering):

- (i) G116V+S126L+P127Q+S128A
- (ii) G116V+S126N+P127S+S128A+S160D
- (iii) G116V+S126L+P127Q+S128A+S160D
- (iv) G116V+S126V+P127E+S128K
- (v) G116V+S126V+P127M+S160D
- (vi) G116V+S126F+P127L+S128T
- (vii) G116V+S126L+P127N+S128V
- (viii) G116V+S126F+P127Q
- (ix) G116V+S126V+P127E+S128K+S160D
- (x) G116V+S126R+P127S+S128P
- (xi) S126R+P127Q+S128D
- (xii) S126C+P127R+S128D
- (xiii) S126C+P127R+S1280
- (xiv) S99G+V102N
- (xv) N74D+N85S+S101A+V102I
- (xvi) V66A+N85S+S99G+V102N

Examples of such low temperature proteases include Polarzyme™, (Novozymes A/S, Bagsvaerd, Denmark), Properase™, Properase BS™, FN3™ and FN4™ (Genencor International Inc., Palo Alto, Calif., USA).

A high temperature protease is characterized in that it has a relative activity of greater than or equal to that of the wild-type from *Bacillus lentus*, sold under the tradenames Savinase™ or Purafect™ at a pH of 9 and a temperature of 60° C. In a preferred embodiment, said high temperature protease is Savinase™ or Purafect™. As used herein, "relative activity" is the fraction derived from dividing the activity of the enzyme at the temperature assayed versus its activity at its optimal temperature measured at a pH of 9.

#### Assay for Protease Activity

Protease activity is measured using Dimethyl Casein (DMC). Release of peptides is initiated via protease action. Protease activity is measured in PU's. 1 PU (protease unit) is the amount of enzyme which hydrolyzes casein such that the initial rate of formation of peptides per minute corresponds to 1 μmole of glycine per minute. 1 KPU is equal to 1000 protease units.

#### Analysis

A 2,4,6 Trinitrobenzenesulphonic acid (TNBSA) solution and a DMC solution are prepared. All ingredients are from Sigma-Aldrich, Milwaukee, USA, unless otherwise stated. The TNBSA solution is made by dissolving 0.40 mL of TNBSA (Sigma Cat No P-2297) in 50 mL of deionized water. The DMC solution is made by dissolving 5.09 g of Potassium Chloride (Sigma Catalogue No: P-3911) and 1.545 g of Boric Acid (Sigma Catalogue No: B-0399) in 500 mL of deionized water. The solution is stirred for 10 mins to dissolve and then the pH adjusted to 9.0 using 50% NaOH. 2 g of DMC are then added (DMC, British Drug House, Cat No. 79457) and the solution is stirred to dissolve.

100 μL of a dilute enzyme containing sample is added (0.5% sodium sulfite solution with 0.04% calcium chloride; Sigma Catalogue No: S-6672 and Sigma Catalogue No: C-5080, respectively) to 1800 μL of DMC solution. The resultant solution is mixed and incubated at 37° C. for 4 minutes. Then 900 μL of TNBSA solution are added to the mixture and incubated for another 5 minutes. The absorbance is read at 415 nm.

Preferably, the variant protease of the invention has an activity of at least 0.3 KNPU per gram of composition, more preferably at least 0.7 KNPU per gram of composition and especially 1 KNPU per gram of composition.

#### Additional Enzymes

Additional enzymes suitable for use in the composition of the invention can comprise one or more enzymes selected from the group comprising hemicellulases, cellulases, cellobiose dehydrogenases, peroxidases, proteases, xylanases, lipases, phospholipases, esterases, cutinases, pectinases, mannanases, pectate lyases, keratinases, reductases, oxidases, phenoloxidases, lipoxigenases, ligninases, pullulanases, tannases, pentosanases, malanases, β-glucanases, arabinosidases, hyaluronidase, chondroitinase, laccase, amylases, and mixtures thereof.

In preferred embodiments, such additional enzyme may be selected from the group consisting of lipases, including "first cycle lipases" comprising a substitution of an electrically neutral or negatively charged amino acid with R or K at any of positions 3, 224, 229, 231 and 233 on the wild-type of *Humicola Lanuginosa*, whose sequence is shown as SEQ ID No 1 in pages 5 and 6 of U.S. Pat. No. 6,939,702 B1, preferably a variant comprising T231R and N233R mutations. One such preferred variant is sold under the tradename Lipex® (Novozymes A/S, Bagsvaerd, Denmark).

Enzyme stabilizer components—Suitable enzyme stabilizers include oligosaccharides, polysaccharides and inorganic divalent metal salts, such as alkaline earth metal salts, especially calcium salts. Chlorides and sulphates are preferred with calcium chloride an especially preferred calcium salt according to the invention. Examples of suitable oligosaccharides and polysaccharides, such as dextrans, can be found in WO07/145964A2 which is incorporated herein by reference. In case of aqueous compositions comprising protease, a reversible protease inhibitor, such as a boron compound, including borate and 4-formyl phenyl boronic acid or a tripeptide aldehyde, can be added to further improve stability.

#### Anti-Redeposition Agent

Suitable for use herein as anti-redeposition agents are non-ionic surfactants. Traditionally, non-ionic surfactants have been used in automatic dishwashing for surface modification purposes in particular for sheeting to avoid filming and spotting and to improve shine. It has been found that in the compositions of the invention non-ionic surfactants contribute to prevent redeposition of soils.

In preferred embodiments the anti-redeposition agent is a non-ionic surfactant or a non-ionic surfactant system having a phase inversion temperature, as measured at a concentration of 1% in distilled water, between 40 and 70° C., preferably between 45 and 65° C. By a “non-ionic surfactant system” is meant herein a mixture of two or more non-ionic surfactants. Preferred for use herein are non-ionic surfactant systems. They seem to have improved cleaning and finishing properties and stability in product than single non-ionic surfactants.

Phase inversion temperature is the temperature below which a surfactant, or a mixture thereof, partitions preferentially into the water phase as oil-swollen micelles and above which it partitions preferentially into the oil phase as water swollen inverted micelles. Phase inversion temperature can be determined visually by identifying at which temperature cloudiness occurs.

The phase inversion temperature of a non-ionic surfactant or system can be determined as follows: a solution containing 1% of the corresponding surfactant or mixture by weight of the solution in distilled water is prepared. The solution is stirred gently before phase inversion temperature analysis to ensure that the process occurs in chemical equilibrium. The phase inversion temperature is taken in a thermostable bath by immersing the solutions in 75 mm sealed glass test tube. To ensure the absence of leakage, the test tube is weighed before and after phase inversion temperature measurement. The temperature is gradually increased at a rate of less than 1° C. per minute, until the temperature reaches a few degrees below the pre-estimated phase inversion temperature. Phase inversion temperature is determined visually at the first sign of turbidity.

Suitable nonionic surfactants include: i) ethoxylated non-ionic surfactants prepared by the reaction of a monohydroxy alkanol or alkylphenol with 6 to 20 carbon atoms with preferably at least 12 moles particularly preferred at least 16 moles, and still more preferred at least 20 moles of ethylene oxide per mole of alcohol or alkylphenol; ii) alcohol alkoxyated surfactants having a from 6 to 20 carbon atoms and at least one ethoxy and propoxy group. Preferred for use herein are mixtures of surfactants i) and ii).

Another suitable non-ionic surfactants are epoxy-capped poly(oxyalkylated) alcohols represented by the formula:



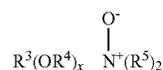
wherein  $R_1$  is a linear or branched, aliphatic hydrocarbon radical having from 4 to 18 carbon atoms;  $R_2$  is a linear or branched aliphatic hydrocarbon radical having from 2 to 26

carbon atoms;  $x$  is an integer having an average value of from 0.5 to 1.5, more preferably about 1; and  $y$  is an integer having a value of at least 15, more preferably at least 20.

Preferably, the surfactant of formula I has at least about 10 carbon atoms in the terminal epoxide unit  $[CH_2CH(OH)R_2]$ . Suitable surfactants of formula I are Olin Corporation's POLY-TERGENT®SLF-18B nonionic surfactants, as described, for example, in WO 94/22800, published Oct. 13, 1994 by Olin Corporation.

Preferably non-ionic surfactants and/or system to use as anti-redeposition agents herein have a Draves wetting time of less than 360 seconds, preferably less than 200 seconds, more preferably less than 100 seconds and especially less than 60 seconds as measured by the Draves wetting method (standard method ISO 8022 using the following conditions; 3-g hook, 5-g cotton skein, 0.1% by weight aqueous solution at a temperature of 25° C.).

Amine oxides surfactants are also useful in the present invention as anti-redeposition surfactants include linear and branched compounds having the formula:



wherein  $R^3$  is selected from an alkyl, hydroxyalkyl, acylamidopropyl and alkyl phenyl group, or mixtures thereof, containing from 8 to 26 carbon atoms, preferably 8 to 18 carbon atoms;  $R^4$  is an alkylene or hydroxyalkylene group containing from 2 to 3 carbon atoms, preferably 2 carbon atoms, or mixtures thereof;  $x$  is from 0 to 5, preferably from 0 to 3; and each  $R^5$  is an alkyl or hydroxyalkyl group containing from 1 to 3, preferably from 1 to 2 carbon atoms, or a polyethylene oxide group containing from 1 to 3, preferable 1, ethylene oxide groups. The  $R^5$  groups can be attached to each other, e.g., through an oxygen or nitrogen atom, to form a ring structure.

These amine oxide surfactants in particular include  $C_{10}$ - $C_{18}$  alkyl dimethyl amine oxides and  $C_8$ - $C_{18}$  alkoxy ethyl dihydroxyethyl amine oxides. Examples of such materials include dimethyloctylamine oxide, diethyldecylamine oxide, bis-(2-hydroxyethyl)dodecylamine oxide, dimethyldodecylamine oxide, dipropyltetradecylamine oxide, methylethylhexadecylamine oxide, dodecylamidopropyl dimethylamine oxide, cetyl dimethylamine oxide, stearyl dimethylamine oxide, tallow dimethylamine oxide and dimethyl-2-hydroxyoctadecylamine oxide. Preferred are  $C_{10}$ - $C_{18}$  alkyl dimethylamine oxide, and  $C_{10-18}$  acylamido alkyl dimethylamine oxide.

Anti-redeposition agents and in particular non-ionic surfactants may be present in amounts from 0 to 10% by weight, preferably from 0.1% to 10%, and most preferably from 0.25% to 6%.

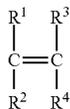
#### Sulfonated Polymer

The polymer, if used, is used in any suitable amount from about 0.1% to about 20%, preferably from 1% to about 15%, more preferably from 2% to 10% by weight of the composition. Sulfonated/carboxylated polymers are particularly suitable for the compositions contained in the pouch of the invention.

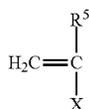
Suitable sulfonated/carboxylated polymers described herein may have a weight average molecular weight of less than or equal to about 100,000 Da, or less than or equal to about 75,000 Da, or less than or equal to about 50,000 Da, or from about 3,000 Da to about 50,000, preferably from about 5,000 Da to about 45,000 Da.

## 13

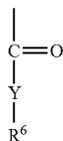
As noted herein, the sulfonated/carboxylated polymers may comprise (a) at least one structural unit derived from at least one carboxylic acid monomer having the general formula (I):



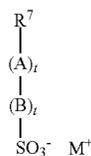
wherein R<sup>1</sup> to R<sup>4</sup> are independently hydrogen, methyl, carboxylic acid group or CH<sub>2</sub>COOH and wherein the carboxylic acid groups can be neutralized; (b) optionally, one or more structural units derived from at least one nonionic monomer having the general formula (II):



wherein R<sup>5</sup> is hydrogen, C<sub>1</sub> to C<sub>6</sub> alkyl, or C<sub>1</sub> to C<sub>6</sub> hydroxyalkyl, and X is either aromatic (with R<sup>5</sup> being hydrogen or methyl when X is aromatic) or X is of the general formula (III):



wherein R<sup>6</sup> is (independently of R<sup>5</sup>) hydrogen, C<sub>1</sub> to C<sub>6</sub> alkyl, or C<sub>1</sub> to C<sub>6</sub> hydroxyalkyl, and Y is O or N; and at least one structural unit derived from at least one sulfonic acid monomer having the general formula (IV):



wherein R<sup>7</sup> is a group comprising at least one sp<sup>2</sup> bond, A is O, N, P, S or an amido or ester linkage, B is a mono- or polycyclic aromatic group or an aliphatic group, each t is independently 0 or 1, and M<sup>+</sup> is a cation. In one aspect, R<sup>7</sup> is a C<sub>2</sub> to C alkene. In another aspect, R<sup>7</sup> is ethene, butene or propene.

Preferred carboxylic acid monomers include one or more of the following: acrylic acid, maleic acid, itaconic acid, methacrylic acid, or ethoxylate esters of acrylic acids, acrylic and methacrylic acids being more preferred. Preferred sulfonated monomers include one or more of the following: sodium(meth)allyl sulfonate, vinyl sulfonate, sodium phenyl (meth)allyl ether sulfonate, or 2-acrylamido-methyl propane sulfonic acid. Preferred non-ionic monomers include one or

## 14

more of the following: methyl(meth)acrylate, ethyl(meth)acrylate, t-butyl(meth)acrylate, methyl(meth)acrylamide, ethyl(meth)acrylamide, t-butyl(meth)acrylamide, styrene, or α-methyl styrene.

5 Preferably, the polymer comprises the following levels of monomers: from about 40 to about 90%, preferably from about 60 to about 90% by weight of the polymer of one or more carboxylic acid monomer; from about 5 to about 50%, preferably from about 10 to about 40% by weight of the polymer of one or more sulfonic acid monomer, and optionally from about 1% to about 30%, preferably from about 2 to about 20% by weight of the polymer of one or more non-ionic monomer. An especially preferred polymer comprises about 70% to about 80% by weight of the polymer of at least one carboxylic acid monomer and from about 20% to about 30% by weight of the polymer of at least one sulfonic acid monomer.

The carboxylic acid is preferably (meth)acrylic acid. The sulfonic acid monomer is preferably one of the following: 20 2-acrylamido methyl-1-propanesulfonic acid, 2-methacrylamido-2-methyl-1-propanesulfonic acid, 3-methacrylamido-2-hydroxypropanesulfonic acid, allylsulfonic acid, methallylsulfonic acid, allyloxybenzenesulfonic acid, methallyloxybenzenesulfonic acid, 2-hydroxy-3-(2-propenyl)propanesulfonic acid, 2-methyl-2-propene-1-sulfonic acid, styrene sulfonic acid, vinylsulfonic acid, 3-sulfopropyl acrylate, 3-sulfopropyl methacrylate, sulfomethylacrylamid, sulfomethylmethacrylamide, and water soluble salts thereof. The unsaturated sulfonic acid monomer is most preferably 30 2-acrylamido-2-propanesulfonic acid (AMPS).

Preferred commercial available polymers include: Alcosperse 240, Aquatreat AR 540 and Aquatreat MPS supplied by Alco Chemical; Acumer 3100, Acumer 2000, Acusol 587G and Acusol 588G supplied by Rohm & Haas; Goodrich 35 K-798, K-775 and K-797 supplied by BF Goodrich; and ACP 1042 supplied by ISP technologies Inc. Particularly preferred polymers are Acusol 587G and Acusol 588G supplied by Rohm & Haas.

In the polymers, all or some of the carboxylic or sulfonic acid groups can be present in neutralized form, i.e. the acidic hydrogen atom of the carboxylic and/or sulfonic acid group in some or all acid groups can be replaced with metal ions, preferably alkali metal ions and in particular with sodium ions.

## 45 Cleaning Actives

Any traditional cleaning ingredients can be used as part of the compositions of invention. The levels given are weight percent and refer to the total composition (excluding the water-soluble film in the case of enveloped composition 50 executions). The detergent compositions can be built or unbuilt and comprise one or more detergent active components which may be selected from bleach, bleach activator, bleach catalyst, surfactants, alkalinity sources, enzymes, polymeric dispersants, anti-corrosion agents (e.g. sodium silicate) and care agents. Highly preferred detergent components include a builder compound, an alkalinity source, an anti-redeposition agent, a sulfonated polymer, an enzyme and an additional bleaching agent.

## Builder

Builders suitable for use herein include builder which forms water-soluble hardness ion complexes (sequestering builder) such as citrates and polyphosphates e.g. sodium triphosphate and sodium tripolyphosphate hexahydrate, potassium tripolyphosphate and mixed sodium and potassium tripolyphosphate salts and builder which forms hardness precipitates (precipitating builder) such as carbonates e.g. sodium carbonate.

## 15

Other suitable builders include amino acid based compound or a succinate based compound. The term "succinate based compound" and "succinic acid based compound" are used interchangeably herein.

Examples of suitable amino acid based compounds include MGDGA (methyl-glycine-diacetic acid), and salts and derivatives thereof and GLDA (glutamic-N,N-diacetic acid) and salts and derivatives thereof. GLDA (salts and derivatives thereof) is especially preferred according to the invention, with the tetrasodium salt thereof being especially preferred. Other suitable builders are described in U.S. Pat. No. 6,426, 229. Particular suitable builders include; for example, aspartic acid-N-monoacetic acid (ASMA), aspartic acid-N,N-diacetic acid (ASDA), aspartic acid-N-monopropionic acid (ASMP), iminodisuccinic acid (IDA), N-(2-sulfomethyl) aspartic acid (SMAS), N-(2-sulfoethyl) aspartic acid (SEAS), N-(2-sulfomethyl) glutamic acid (SMGL), N-(2-sulfoethyl) glutamic acid (SEGL), N-methyliminodiacetic acid (MIDA),  $\alpha$ -alanine-N,N-diacetic acid ( $\alpha$ -ALDA), serine-N,N-diacetic acid (SEDA), isoserine-N,N-diacetic acid (ISDA), phenylalanine-N,N-diacetic acid (PHDA), anthranilic acid-N,N-diacetic acid (ANDA), sulfanilic acid-N,N-diacetic acid (SLDA), taurine-N,N-diacetic acid (TUDA) and sulfomethyl-N,N-diacetic acid (SMDA) and alkali metal salts or ammonium salts thereof.

Preferably the amino acid based compound or succinate based compound is present in the composition in an amount of at least 1 wt %, preferably at least 5 wt %, more preferably at least 10 wt %, and most preferably at least 20 wt %. Preferably these compounds are present in an amount of up to 50 wt %, preferably up to 45 wt %, more preferably up to 40 wt %, and most preferably up to 35 wt %. It is preferred that the composition contains 20% wt or less of phosphorous-containing ingredients, more preferably 10% wt or less, most preferably that they are substantially free of such ingredients and even more preferably they are free of such ingredients.

Other builders include homopolymers and copolymers of polycarboxylic acids and their partially or completely neutralized salts, monomeric polycarboxylic acids and hydroxycarboxylic acids and their salts. Preferred salts of the above-mentioned compounds are the ammonium and/or alkali metal salts, i.e. the lithium, sodium, and potassium salts, and particularly preferred salts are the sodium salts.

Suitable polycarboxylic acids are acyclic, alicyclic, heterocyclic and aromatic carboxylic acids, in which case they contain at least two carboxyl groups which are in each case separated from one another by, preferably, no more than two carbon atoms. Polycarboxylates which comprise two carboxyl groups include, for example, water-soluble salts of, malonic acid, (ethyl enedioxy) diacetic acid, maleic acid, diglycolic acid, tartaric acid, tartronic acid and fumaric acid. Polycarboxylates which contain three carboxyl groups include, for example, water-soluble citrate. Correspondingly, a suitable hydroxycarboxylic acid is, for example, citric acid. Another suitable polycarboxylic acid is the homopolymer of acrylic acid. Other suitable builders are disclosed in WO 95/01416, to the contents of which express reference is hereby made.

The builder is typically present at a level of from about 30 to about 80%, preferably from about 40 to about 70% by weight of composition. It is also preferred that the ratio of sequestering builder to precipitating builder is from about 10:1 to about 1:1, preferably from about 8:1 to 2:1.

## Silicates

Preferred silicates are sodium silicates such as sodium disilicate, sodium metasilicate and crystalline phyllosilicates.

## 16

Silicates if present are at a level of from about 1 to about 20%, preferably from about 5 to about 15% by weight of composition.

## Bleach

Inorganic and organic bleaches are suitable cleaning actives for use herein. Inorganic bleaches include perhydrate salts such as perborate, percarbonate, perphosphate, persulfate and persilicate salts. The inorganic perhydrate salts are normally the alkali metal salts. The inorganic perhydrate salt may be included as the crystalline solid without additional protection. Alternatively, the salt can be coated.

Alkali metal percarbonates, particularly sodium percarbonate are preferred perhydrates for use herein. The percarbonate is most preferably incorporated into the products in a coated form which provides in-product stability. A suitable coating material providing in product stability comprises mixed salt of a water-soluble alkali metal sulphate and carbonate. Such coatings together with coating processes have previously been described in GB-1,466,799. The weight ratio of the mixed salt coating material to percarbonate lies in the range from 1:200 to 1:4, more preferably from 1:99 to 1:9, and most preferably from 1:49 to 1:19. Preferably, the mixed salt is of sodium sulphate and sodium carbonate which has the general formula  $\text{Na}_2\text{SO}_4 \cdot n \cdot \text{Na}_2\text{CO}_3$  wherein n is from 0.1 to 3, preferably n is from 0.3 to 1.0 and most preferably n is from 0.2 to 0.5.

Another suitable coating material providing in product stability, comprises sodium silicate of SiO<sub>2</sub>: Na<sub>2</sub>O ratio from 1.8:1 to 3.0:1, preferably 1.8:1 to 2.4:1, and/or sodium metasilicate, preferably applied at a level of from 2% to 10%, (normally from 3% to 5%) of SiO<sub>2</sub> by weight of the inorganic perhydrate salt. Magnesium silicate can also be included in the coating. Coatings that contain silicate and borate salts or boric acids or other inorganics are also suitable.

Other coatings which contain waxes, oils, fatty soaps can also be used advantageously within the present invention.

Potassium peroxymonopersulfate is another inorganic perhydrate salt of utility herein.

Typical organic bleaches are organic peroxyacids including diacyl and tetraacylperoxides, especially diperoxydodecanedioic acid, diperoxytetradecanedioic acid, and diperoxyhexadecanedioic acid. Dibenzoyl peroxide is a preferred organic peroxyacid herein. Mono- and diperazelaic acid, mono- and diperbrassylic acid, and Nphthaloylaminoperoxydicapric acid are also suitable herein.

The diacyl peroxide, especially dibenzoyl peroxide, should preferably be present in the form of particles having a weight average diameter of from about 0.1 to about 100 microns, preferably from about 0.5 to about 30 microns, more preferably from about 1 to about 10 microns. Preferably, at least about 25%, more preferably at least about 50%, even more preferably at least about 75%, most preferably at least about 90%, of the particles are smaller than 10 microns, preferably smaller than 6 microns. Diacyl peroxides within the above particle size range have also been found to provide better stain removal especially from plastic dishware, while minimizing undesirable deposition and filming during use in automatic dishwashing machines, than larger diacyl peroxide particles. The preferred diacyl peroxide particle size thus allows the formulator to obtain good stain removal with a low level of diacyl peroxide, which reduces deposition and filming. Conversely, as diacyl peroxide particle size increases, more diacyl peroxide is needed for good stain removal, which increases deposition on surfaces encountered during the dishwashing process.

Further typical organic bleaches include the peroxy acids, particular examples being the alkylperoxy acids and the

17

arylperoxy acids. Preferred representatives are (a) peroxybenzoic acid and its ring-substituted derivatives, such as alkylperoxybenzoic acids, but also peroxy- $\alpha$ -naphthoic acid and magnesium monopero-phthalate, (b) the aliphatic or substituted aliphatic peroxy acids, such as peroxy-lauric acid, peroxy-stearic acid,  $\epsilon$ -phthalimidoperoxy-caproic acid [phthaloinoperoxyhexanoic acid (PAP)], o-carboxybenzamidoperoxy-caproic acid, N-nonylamidoperadipic acid and N-nonylamidopersuccinates, and (c) aliphatic and araliphatic peroxydicarboxylic acids, such as 1,12-diperoxy-carboxylic acid, 1,9-diperoxyazelaic acid, diperoxysebacic acid, diperoxybrassylic acid, the diperoxyphthalic acids, 2-decyldiperoxybutane-1,4-dioic acid, N,N-terephthaloyldi (6-aminopercaproic acid).

#### Bleach Activators

Bleach activators are typically organic peracid precursors that enhance the bleaching action in the course of cleaning at temperatures of 60° C. and below. Bleach activators suitable for use herein include compounds which, under perhydrolysis conditions, give aliphatic peroxy-carboxylic acids having preferably from 1 to 10 carbon atoms, in particular from 2 to 4 carbon atoms, and/or optionally substituted perbenzoic acid. Suitable substances bear O-acyl and/or N-acyl groups of the number of carbon atoms specified and/or optionally substituted benzoyl groups. Preference is given to polyacylated alkylenediamines, in particular tetraacetylenediamine (TAED), acylated triazine derivatives, in particular 1,5-diacetyl-2,4-dioxohexahydro-1,3,5-triazine (DADHT), acylated glycolurils, in particular tetraacetyl-glycoluril (TAGU), N-acylimides, in particular N-nonylsuccinimide (NOSI), acylated phenolsulfonates, in particular n-nonyl- or isononyloxybenzenesulfonate (n- or iso-NOBS), carboxylic anhydrides, in particular phthalic anhydride, acylated polyhydric alcohols, in particular triacetin, ethylene glycol diacetate and 2,5-diacetoxy-2,5-dihydrofuran and also triethylacetyl citrate (TEAC). Bleach activators if included in the compositions of the invention are in a level of from about 0.1 to about 10%, preferably from about 0.5 to about 2% by weight of the composition.

#### Bleach Catalyst

Bleach catalysts preferred for use herein include the manganese triazacyclononane and related complexes (U.S. Pat. No. 4,246,612, U.S. Pat. No. 5,227,084); Co, Cu, Mn and Fe bispyridylamine and related complexes (U.S. Pat. No. 5,114,611); and pentamine acetate cobalt(II) and related complexes (U.S. Pat. No. 4,810,410). A complete description of bleach catalysts suitable for use herein can be found in WO 99/06521, pages 34, line 26 to page 40, line 16. Bleach catalyst if included in the compositions of the invention are in a level of from about 0.1 to about 10%, preferably from about 0.5 to about 2% by weight of the composition.

#### Metal Care Agents

Metal care agents may prevent or reduce the tarnishing, corrosion or oxidation of metals, including aluminium, stainless steel and non-ferrous metals, such as silver and copper. Suitable examples include one or more of the following:

- (a) benzotriazoles, including benzotriazole or bis-benzotriazole and substituted derivatives thereof. Benzotriazole derivatives are those compounds in which the available substitution sites on the aromatic ring are partially or completely substituted. Suitable substituents include linear or branch-chain C<sub>1</sub>-C<sub>20</sub>-alkyl groups and hydroxyl, thio, phenyl or halogen such as fluorine, chlorine, bromine and iodine.
- (b) metal salts and complexes chosen from the group consisting of zinc, manganese, titanium, zirconium, hafnium, vanadium, cobalt, gallium and cerium salts

18

and/or complexes, the metals being in one of the oxidation states II, III, IV, V or VI. In one aspect, suitable metal salts and/or metal complexes may be chosen from the group consisting of Mn(II) sulphate, Mn(II) citrate, Mn(II) stearate, Mn(II) acetylacetonate, K<sub>2</sub>TiF<sub>6</sub>, K<sub>2</sub>ZrF<sub>6</sub>, COSO<sub>4</sub>, Co(NO<sub>3</sub>)<sub>2</sub> and Ce(NO<sub>3</sub>)<sub>3</sub>, zinc salts, for example zinc sulphate, hydrozincite or zinc acetate; (c) silicates, including sodium or potassium silicate, sodium disilicate, sodium metasilicate, crystalline phyllosilicate and mixtures thereof.

Further suitable organic and inorganic redox-active substances that act as silver/copper corrosion inhibitors are disclosed in WO 94/26860 and WO 94/26859.

Preferably the composition of the invention comprises from 0.1 to 5% by weight of the composition of a metal care agent, preferably the metal care agent is a zinc salt.

#### Unit Dose

Products in unit dose form include tablets, capsules, sachets, pouches, etc. Preferred for use herein are pouches, in particular multi-compartment pouches.

A multi-compartment pouch is formed by a plurality of water-soluble films which form a plurality of compartments. The pouch preferably comprises at least two side-by-side compartments superposed (i.e., placed above) onto another compartment. This disposition contributes to the compactness, robustness and strength of the pouch, additionally, it minimises the amount of water-soluble film required. It only requires three pieces of film to form three compartments. The robustness of the pouch allows also for the use of very thin films without compromising the physical integrity of the pouch. The pouch is also very easy to use because the compartments do not need to be folded to be used in dispensers of fix geometry. At least two of the compartments of the pouch contain two different compositions. By "different compositions" herein is meant compositions that differ in at least one ingredient.

Preferably, at least one of the compartments contains a solid composition and another compartment a liquid composition, the compositions are preferably in a solid to liquid weight ratio of from about 20:1 to about 1:20, more preferably from about 18:1 to about 2:1 and even more preferably from about 15:1 to about 5:1. The pouch of the invention is very versatile because it can accommodate compositions having a broad spectrum of values of solid:liquid ratio. Particularly preferred have been found to be pouches having a high solid:liquid ratio because many of the detergent ingredients are most suitable for use in solid form, preferably in powder form. The ratio solid:liquid defined herein refers to the relationship between the weight of all the solid compositions and the weight of all the liquid compositions in the pouch.

In other embodiments the solid:liquid weight ratio is from about 2:1 to about 18:1, more preferably from about 5:1 to about 15:1. These weight ratios are suitable in cases in which most of the ingredients of the detergent are in liquid form.

In preferred embodiments the two side-by-side compartments contain liquid compositions, which can be the same but preferably are different and another compartment contains a solid composition, preferably in powder form, more preferably a densified powder. The solid composition contributes to the strength and robustness of the pouch. The liquid compositions contribute to the stability of the pouch, in particular if the solid composition comprises moisture sensitive ingredients (such as bleach). This is more so if the compartments superposed onto the solid-containing compartment cover completely the top surface (i.e. the common solid/liquid surface) of the solid-containing compartment.

For dispenser fit reasons the unit dose form products herein have a square or rectangular base and a height of from about 1 to about 5 cm, more preferably from about 1 to about 4 cm. Preferably the weight of the solid composition is from about 10 to about 22 grams, more preferably from about 15 to about 20 grams and the weight of the liquid compositions is from about 0.5 to about 4 grams, more preferably from about 0.8 to about 3 grams.

The multi-compartment pouch of the invention is very versatile in terms of dissolution profile. In preferred embodiments, at least two of the films which form different compartments have different solubility, under the same conditions, releasing the content of the compositions which they partially or totally envelope at different times. The term "solubility" as used herein is not intended to refer to total solubility of a film but to the point at which the pouch in the wash solution breaks to release its content.

The enzymes can lose stability in product, due to its interaction with bleach and builders (they can destabilize the enzyme by binding to the calcium of the enzymes). In addition, the performance of enzymes in a cleaning solution can be impaired by the alkalinity of the solution, bleach, builders, etc. In preferred embodiments, one of the compositions of the multi-compartment pouch, preferably a solid composition, comprises bleach and another composition, preferably a composition in liquid form, comprises enzymes. It is also preferred that one of the films enclosing the enzyme-comprising composition dissolves prior to the films enclosing the bleach-containing composition during the main-wash cycle of an automatic dishwashing machine, thereby releasing the enzyme-containing composition into the wash liquor prior to the delivery of the bleach-containing composition. This gives the enzymes the possibility to operate under optimum condition, avoiding interactions with other detergent actives. The pouch provides excellent cleaning. It is preferred that the bleach-containing composition comprises also a builder.

Controlled release of the ingredients of a multi-compartment pouch can be achieved by modifying the thickness of the film and/or the solubility of the film material. The solubility of the film material can be delayed by for example cross-linking the film as described in WO 02/102,955 at pages 17 and 18. Other water-soluble films designed for rinse release are described in U.S. Pat. No. 4,765,916 and U.S. Pat. No. 4,972,017. Waxy coating (see WO 95/29982) of films can help with rinse release. pH controlled release means are described in WO 04/111178, in particular amino-acetylated polysaccharide having selective degree of acetylation.

Other means of obtaining delayed release by multi-compartment pouches with different compartments, where the compartments are made of films having different solubility are taught in WO 02/08380.

#### ABBREVIATIONS USED IN THE EXAMPLE

In the example, the abbreviated component identifications have the following meanings:

Carbonate: Anhydrous sodium carbonate

STPP: Sodium tripolyphosphate anhydrous

Silicate: Amorphous Sodium Silicate (SiO<sub>2</sub>:Na<sub>2</sub>O=from 2:1 to 4:1)

Alcosperse 240-D: Sulfonated polymer available from Alco Chemical 95% solids

Percarbonate: Sodium percarbonate of the nominal formula 2Na<sub>2</sub>CO<sub>3</sub>·3H<sub>2</sub>O<sub>2</sub>

TAED: Tetraacetylenediamine

Detergency enzyme: available from Novozymes A/S

SLF18: Non-ionic surfactant available from BASF

Neodol 1-9: Non-ionic surfactant available from Shell

DPG: dipropylene glycol

In the following example all levels are quoted in percent by weight of the composition (either solid or liquid composition).

#### EXAMPLE

The compositions tabulated below are introduced into a multi-compartment pouch having a first compartment comprising the solid composition (in powder form) and a liquid compartment superposed onto the powder compartment comprising the liquid compositions. The film used is Monosol M8630 film as supplied by Monosol. The weight of the solid composition is 17 grams and the weight of liquid compositions is 2.6 gram.

The pouch also comprises 0.3 mg of active amylase and 2 mg of active protease per gram of product.

Ingredient	Level (% wt)
<u>Solid composition</u>	
STPP	35
Carbonate	24
Silicate	7
TAED	0.5
Zinc carbonate	0.5
SLF18	1.5
Percarbonate	15
Alcosperse 240D	10
Processing aids	To balance
<u>Liquid composition</u>	
DPG	45
SLF18	45
Neodol 1-9	3
Glycerine	2
Processing aids	To balance

The exemplified pouch is used to wash a soiled load as described herein below in an automatic dishwasher under the conditions described herein below. The washing items present excellent shine.

#### Substrate/Soils

Coming ware round casserole dish with egg,

1 part of butter with 50 cc of egg in microwave 4¼ minutes.

2 casserole dishes per run

#### Stainless steel pot

Painted with 10 grams of cooked and blended Kraft

Macaroni and cheese

Baked in over for seven minutes

2 stainless steel pots per run

#### China Vertex plate

Painted with five grams of cooked and blended Minute

Rice

Dry overnight

2 plates per run

#### Black Ceramic Plates

Painted with 5 grams of a composite soil (TMD) comprising eggs, vegetables, meat, and cereals.

Allowed to dry over night

4 plates per run

TMD soil is made by J&R.

#### Stainless Steel Spatulas

Painted with five grams of TMD soil

Allowed to dry overnight

4 spatulas per run

## Test Conditions:

Bank of four machines GE2600  
 City Water (8 gpg)  
 Four products  
 120° F. Inlet Water temperature  
 Normal cycle/heated dry  
 Substrates listed above are placed in the dishwasher  
 50 grams of the TMD soil is added when the main wash cup  
 opens

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm".

Every document cited herein, including any cross referenced or related patent or application, is hereby incorporated

herein by reference in its entirety unless expressly excluded or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

## SEQUENCE LISTING

<160> NUMBER OF SEQ ID NOS: 5

<210> SEQ ID NO 1

<211> LENGTH: 269

<212> TYPE: PRT

<213> ORGANISM: Bacillus Alkalophilus PB92

<400> SEQUENCE: 1

```

Ala Gln Ser Val Pro Trp Gly Ile Ser Arg Val Gln Ala Pro Ala Ala
1          5          10          15
His Asn Arg Gly Leu Thr Gly Ser Gly Val Lys Val Ala Val Leu Asp
20        25        30
Thr Gly Ile Ser Thr His Pro Asp Leu Asn Ile Arg Gly Gly Ala Ser
35        40        45
Phe Val Pro Gly Glu Pro Ser Thr Gln Asp Gly Asn Gly His Gly Thr
50        55        60
His Val Ala Gly Thr Ile Ala Ala Leu Asn Asn Ser Ile Gly Val Leu
65        70        75        80
Gly Val Ala Pro Asn Ala Glu Leu Tyr Ala Val Lys Val Leu Gly Ala
85        90        95
Ser Gly Ser Gly Ser Val Ser Ser Ile Ala Gln Gly Leu Glu Trp Ala
100       105       110
Gly Asn Asn Gly Met His Val Ala Asn Leu Ser Leu Gly Ser Pro Ser
115       120       125
Pro Ser Ala Thr Leu Glu Gln Ala Val Asn Ser Ala Thr Ser Arg Gly
130       135       140
Val Leu Val Val Ala Ala Ser Gly Asn Ser Gly Ala Gly Ser Ile Ser
145       150       155       160
Tyr Pro Ala Arg Tyr Ala Asn Ala Met Ala Val Gly Ala Thr Asp Gln
165       170       175
Asn Asn Asn Arg Ala Ser Phe Ser Gln Tyr Gly Ala Gly Leu Asp Ile
180       185       190
Val Ala Pro Gly Val Asn Val Gln Ser Thr Tyr Pro Gly Ser Thr Tyr
195       200       205
Ala Ser Leu Asn Gly Thr Ser Met Ala Thr Pro His Val Ala Gly Ala
210       215       220
Ala Ala Leu Val Lys Gln Lys Asn Pro Ser Trp Ser Asn Val Gln Ile
225       230       235       240

```

-continued

---

Arg Asn His Leu Lys Asn Thr Ala Thr Ser Leu Gly Ser Thr Asn Leu  
245 250 255

Tyr Gly Ser Gly Leu Val Asn Ala Glu Ala Ala Thr Arg  
260 265

<210> SEQ ID NO 2

<211> LENGTH: 485

<212> TYPE: PRT

<213> ORGANISM: Bacillus AA560

<400> SEQUENCE: 2

His His Asn Gly Thr Asn Gly Thr Met Met Gln Tyr Phe Glu Trp Tyr  
1 5 10 15

Leu Pro Asn Asp Gly Asn His Trp Asn Arg Leu Arg Ser Asp Ala Ser  
20 25 30

Asn Leu Lys Asp Lys Gly Ile Ser Ala Val Trp Ile Pro Pro Ala Trp  
35 40 45

Lys Gly Ala Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr  
50 55 60

Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Ile Arg Thr Lys Tyr Gly  
65 70 75 80

Thr Arg Asn Gln Leu Gln Ala Ala Val Asn Ala Leu Lys Ser Asn Gly  
85 90 95

Ile Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp  
100 105 110

Ala Thr Glu Met Val Arg Ala Val Glu Val Asn Pro Asn Asn Arg Asn  
115 120 125

Gln Glu Val Ser Gly Glu Tyr Thr Ile Glu Ala Trp Thr Lys Phe Asp  
130 135 140

Phe Pro Gly Arg Gly Asn Thr His Ser Asn Phe Lys Trp Arg Trp Tyr  
145 150 155 160

His Phe Asp Gly Val Asp Trp Asp Gln Ser Arg Lys Leu Asn Asn Arg  
165 170 175

Ile Tyr Lys Phe Arg Gly Asp Gly Lys Gly Trp Asp Trp Glu Val Asp  
180 185 190

Thr Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp Met  
195 200 205

Asp His Pro Glu Val Val Asn Glu Leu Arg Asn Trp Gly Val Trp Tyr  
210 215 220

Thr Asn Thr Leu Gly Leu Asp Gly Phe Arg Ile Asp Ala Val Lys His  
225 230 235 240

Ile Lys Tyr Ser Phe Thr Arg Asp Trp Ile Asn His Val Arg Ser Ala  
245 250 255

Thr Gly Lys Asn Met Phe Ala Val Ala Glu Phe Trp Lys Asn Asp Leu  
260 265 270

Gly Ala Ile Glu Asn Tyr Leu Asn Lys Thr Asn Trp Asn His Ser Val  
275 280 285

Phe Asp Val Pro Leu His Tyr Asn Leu Tyr Asn Ala Ser Lys Ser Gly  
290 295 300

Gly Asn Tyr Asp Met Arg Gln Ile Phe Asn Gly Thr Val Val Gln Arg  
305 310 315 320

His Pro Met His Ala Val Thr Phe Val Asp Asn His Asp Ser Gln Pro  
325 330 335

Glu Glu Ala Leu Glu Ser Phe Val Glu Glu Trp Phe Lys Pro Leu Ala  
340 345 350

-continued

---

Tyr Ala Leu Thr Leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr  
                   355                                  360                                  365  
 Gly Asp Tyr Tyr Gly Ile Pro Thr His Gly Val Pro Ala Met Lys Ser  
                   370                                  375                                  380  
 Lys Ile Asp Pro Ile Leu Glu Ala Arg Gln Lys Tyr Ala Tyr Gly Arg  
                   385                                  390                                  395                                  400  
 Gln Asn Asp Tyr Leu Asp His His Asn Ile Ile Gly Trp Thr Arg Glu  
                                   405                                  410  
 Gly Asn Thr Ala His Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asp  
                                   420                                  425                                  430  
 Gly Ala Gly Gly Asn Lys Trp Met Phe Val Gly Arg Asn Lys Ala Gly  
                                   435                                  440                                  445  
 Gln Val Trp Thr Asp Ile Thr Gly Asn Arg Ala Gly Thr Val Thr Ile  
                                   450                                  455                                  460  
 Asn Ala Asp Gly Trp Gly Asn Phe Ser Val Asn Gly Gly Ser Val Ser  
                                   465                                  470                                  475                                  480  
 Ile Trp Val Asn Lys  
                                   485

&lt;210&gt; SEQ ID NO 3

&lt;211&gt; LENGTH: 483

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Bacillus Licheniformis

&lt;400&gt; SEQUENCE: 3

Ala Asn Leu Asn Gly Thr Leu Met Gln Tyr Phe Glu Trp Tyr Met Pro  
 1                  5                                  10                                  15  
 Asn Asp Gly Gln His Trp Arg Arg Leu Gln Asn Asp Ser Ala Tyr Leu  
                   20                                  25                                  30  
 Ala Glu His Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Tyr Lys Gly  
                   35                                  40                                  45  
 Thr Ser Gln Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu  
                   50                                  55                                  60  
 Gly Glu Phe His Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys  
                   65                                  70                                  75                                  80  
 Gly Glu Leu Gln Ser Ala Ile Lys Ser Leu His Ser Arg Asp Ile Asn  
                                   85                                  90                                  95  
 Val Tyr Gly Asp Val Val Ile Asn His Lys Gly Gly Ala Asp Ala Thr  
                                   100                                  105                                  110  
 Glu Asp Val Thr Ala Val Glu Val Asp Pro Ala Asp Arg Asn Arg Val  
                   115                                  120                                  125  
 Ile Ser Gly Glu His Arg Ile Lys Ala Trp Thr His Phe His Phe Pro  
                   130                                  135                                  140  
 Gly Arg Gly Ser Thr Tyr Ser Asp Phe Lys Trp His Trp Tyr His Phe  
                   145                                  150                                  155                                  160  
 Asp Gly Thr Asp Trp Asp Glu Ser Arg Lys Leu Asn Arg Ile Tyr Lys  
                                   165                                  170                                  175  
 Phe Gln Gly Lys Ala Trp Asp Trp Glu Val Ser Asn Glu Asn Gly Asn  
                                   180                                  185                                  190  
 Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp Tyr Asp His Pro Asp Val  
                   195                                  200                                  205  
 Ala Ala Glu Ile Lys Arg Trp Gly Thr Trp Tyr Ala Asn Glu Leu Gln  
                   210                                  215                                  220  
 Leu Asp Gly Phe Arg Leu Asp Ala Val Lys His Ile Lys Phe Ser Phe  
                   225                                  230                                  235                                  240



-continued

---

Pro Ser Ala Thr Leu Glu Gln Ala Val Asn Ser Ala Thr Ser Arg Gly  
 130 135 140

Val Leu Val Val Ala Ala Ser Gly Asn Ser Gly Ala Ser Ser Ile Ser  
 145 150 155 160

Tyr Pro Ala Arg Tyr Ala Asn Ala Met Ala Val Gly Ala Thr Asp Gln  
 165 170 175

Asn Asn Asn Arg Ala Ser Phe Ser Gln Tyr Gly Ala Gly Leu Asp Ile  
 180 185 190

Val Ala Pro Gly Val Asn Val Gln Ser Thr Tyr Pro Gly Ser Thr Tyr  
 195 200 205

Ala Ser Leu Asn Gly Thr Ser Met Ala Thr Pro His Val Ala Gly Ala  
 210 215 220

Ala Ala Leu Val Lys Gln Lys Asn Pro Ser Trp Ser Asn Val Gln Ile  
 225 230 235 240

Arg Asn His Leu Lys Asn Thr Ala Thr Ser Leu Gly Ser Thr Asn Leu  
 245 250 255

Tyr Gly Ser Gly Leu Val Asn Ala Glu Ala Ala Thr Arg  
 260 265

<210> SEQ ID NO 5  
 <211> LENGTH: 485  
 <212> TYPE: PRT  
 <213> ORGANISM: Bacillus sp. 707

<400> SEQUENCE: 5

His His Asn Gly Thr Asn Gly Thr Met Met Gln Tyr Phe Glu Trp Tyr  
 1 5 10 15

Leu Pro Asn Asp Gly Asn His Trp Asn Arg Leu Asn Ser Asp Ala Ser  
 20 25 30

Asn Leu Lys Ser Lys Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Trp  
 35 40 45

Lys Gly Ala Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr  
 50 55 60

Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly  
 65 70 75 80

Thr Arg Ser Gln Leu Gln Ala Ala Val Thr Ser Leu Lys Asn Asn Gly  
 85 90 95

Ile Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp  
 100 105 110

Ala Thr Glu Met Val Arg Ala Val Glu Val Asn Pro Asn Asn Arg Asn  
 115 120 125

Gln Glu Val Thr Gly Glu Tyr Thr Ile Glu Ala Trp Thr Arg Phe Asp  
 130 135 140

Phe Pro Gly Arg Gly Asn Thr His Ser Ser Phe Lys Trp Arg Trp Tyr  
 145 150 155 160

His Phe Asp Gly Val Asp Trp Asp Gln Ser Arg Arg Leu Asn Asn Arg  
 165 170 175

Ile Tyr Lys Phe Arg Gly His Gly Lys Ala Trp Asp Trp Glu Val Asp  
 180 185 190

Thr Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp Met  
 195 200 205

Asp His Pro Glu Val Val Asn Glu Leu Arg Asn Trp Gly Val Trp Tyr  
 210 215 220

Thr Asn Thr Leu Gly Leu Asp Gly Phe Arg Ile Asp Ala Val Lys His  
 225 230 235 240

-continued

---

Ile Lys Tyr Ser Phe Thr Arg Asp Trp Ile Asn His Val Arg Ser Ala  
 245 250 255

Thr Gly Lys Asn Met Phe Ala Val Ala Glu Phe Trp Lys Asn Asp Leu  
 260 265 270

Gly Ala Ile Glu Asn Tyr Leu Gln Lys Thr Asn Trp Asn His Ser Val  
 275 280 285

Phe Asp Val Pro Leu His Tyr Asn Leu Tyr Asn Ala Ser Lys Ser Gly  
 290 295 300

Gly Asn Tyr Asp Met Arg Asn Ile Phe Asn Gly Thr Val Val Gln Arg  
 305 310 315

His Pro Ser His Ala Val Thr Phe Val Asp Asn His Asp Ser Gln Pro  
 325 330 335

Glu Glu Ala Leu Glu Ser Phe Val Glu Glu Trp Phe Lys Pro Leu Ala  
 340 345 350

Tyr Ala Leu Thr Leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr  
 355 360 365

Gly Asp Tyr Tyr Gly Ile Pro Thr His Gly Val Pro Ala Met Arg Ser  
 370 375 380

Lys Ile Asp Pro Ile Leu Glu Ala Arg Gln Lys Tyr Ala Tyr Gly Lys  
 385 390 395 400

Gln Asn Asp Tyr Leu Asp His His Asn Ile Ile Gly Trp Thr Arg Glu  
 405 410 415

Gly Asn Thr Ala His Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asp  
 420 425 430

Gly Ala Gly Gly Ser Lys Trp Met Phe Val Gly Arg Asn Lys Ala Gly  
 435 440 445

Gln Val Trp Ser Asp Ile Thr Gly Asn Arg Thr Gly Thr Val Thr Ile  
 450 455 460

Asn Ala Asp Gly Trp Gly Asn Phe Ser Val Asn Gly Gly Ser Val Ser  
 465 470 475 480

Ile Trp Val Asn Lys  
 485

---

What is claimed is:

1. An automatic dishwashing detergent composition in unit dose form, said composition having a total weight of less than 25 grams, said composition comprising bleach and from 0.2 mg to about 10 mg of an alpha-amylase per gram of composition, said alpha-amylase being selected from the group consisting of alpha-amylases having:
  - (a) one or more, substitutions in the following positions versus SEQ ID NO: 2: 9, 26, 149, 182, 186, 202, 257, 295, 299, 323, 339 and 345; and optionally one or more substitutions and/or deletions in the following positions: 118, 183, 184, 195, 320 and 458;
  - (b) at least one substitution in the following positions versus SEQ ID NO:5: M202, M208, S255, R172 and/or M261;
  - (c) and mixtures thereof; and
 

wherein the detergent composition is preventing grit formation on washed items in the automatic dishwashing.
2. The automatic dishwashing detergent composition according to claim 1, wherein said alpha-amylase has:
  - (a) three or more substitutions in the following positions versus SEQ ID NO: 2: 9, 26, 149, 182, 186, 202, 257, 295, 299, 323, 339 and 345; and one or more substitutions and/or deletions in the following positions: 118, 183, 184, 195, 320 and 458; or
  - (b) at least one substitution in the following positions versus SEQ ID NO:5: M202L, M202V, M202S, M202T, M202I, M202Q, M202W, S255N and/or R172Q.
3. The automatic dishwashing detergent composition according to claim 2, wherein said alpha-amylase has:
  - (a) one or more of the following substitutions and/or deletions in the following positions: R118K, D183\*, G184\*, N195F, R320K and/or R458K; or
  - (b) one of the following substitutions M202L or M202T mutations.
4. The automatic dishwashing detergent composition according to claim 1, wherein said bleach comprises peroxy acids and/or alkali metal percarbonates.
5. The automatic dishwashing detergent composition according to claim 1 comprising a sulfonated polymer.
6. The automatic dishwashing detergent composition according to claim 1 comprising at least 1 mg of active protease per gram of the composition.
7. The automatic dishwashing detergent composition according to claim 6, wherein the protease is a low temperature protease.
8. The automatic dishwashing detergent composition according to claim 1 comprising a lipase.

33

9. The automatic dishwashing detergent composition according to claim 1 comprising an anti-redeposition agent.

10. The automatic dishwashing detergent composition according to claim 1, wherein the anti-redeposition agent is a non-ionic surfactant or a non-ionic surfactant system having a phase inversion temperature between 40 and 70° C.

11. The automatic dishwashing detergent composition according to claim 1, wherein the unit dose form is a water-soluble pouch.

12. The automatic dishwashing detergent composition according to claim 11, wherein said water-soluble pouch is a multi-compartment pouch having a plurality of films forming a plurality of compartments.

13. The automatic dishwashing detergent composition according to claim 12, wherein the pouch comprises two side-by-side compartments superposed onto another compartment wherein at least two different compartments contain two different compositions.

14. The automatic dishwashing detergent composition according to claim 11, wherein at least two different compartments contain an anti-redeposition agent.

15. The automatic dishwashing detergent composition according to claim 11, wherein one compartment contains a composition in solid form and another compartment contains a composition in liquid form.

16. A method of dishwashing in an automatic dishwashing machine comprising the step of placing a composition according to claim 1 into the product dispenser and releasing it during the main-wash cycle.

17. A method of preventing grit formation in automatic dishwashing comprising practicing the method of claim 16.

18. A method of dishwashing in an automatic dishwashing machine using a detergent composition according to claim 1 comprising the steps of: a) placing the pouch into the product dispenser and releasing it during the main-wash cycle; and b) releasing anti-redeposition agent into the wash liquor at two different points in time of the main-wash cycle.

34

19. The automatic dishwashing detergent composition according to claim 1 comprising from about 0.3 mg to about 4 mg of an alpha-amylase per gram of composition.

20. The automatic dishwashing detergent composition according to claim 1 comprising a builder.

21. The automatic dishwashing detergent composition according to claim 20 comprising a citrate based builder or an amino acid based builder.

22. The automatic dishwashing detergent composition according to claim 21 comprising an amino acid based builder selected from the group consisting of MGDA (methyl-glycine-diacetic acid), and salts and derivatives thereof; GLDA (glutamic-N,N-diacetic acid) and salts and derivatives thereof; aspartic acid-N-monoacetic acid (ASMA); aspartic acid-N,N-diacetic acid (ASDA); aspartic acid-N-monopropionic acid (ASMP); iminodisuccinic acid (IDA); N-(2-sulfomethyl) aspartic acid (SMAS); N-(2-sulfoethyl) aspartic acid (SEAS); N-(2-sulfomethyl) glutamic acid (SMGL); N-(2-sulfoethyl) glutamic acid (SEGL); N-methyliminodiacetic acid (MIDA);  $\alpha$ -alanine-N,N-diacetic acid ( $\alpha$ -ALDA); serine-N,N-diacetic acid (SEDA); isoserine-N,N-diacetic acid (ISDA); phenylalanine-N,N-diacetic acid (PHDA); anthranilic acid-N,N-diacetic acid (ANDA); sulfanilic acid-N,N-diacetic acid (SLDA); taurine-N,N-diacetic acid (TUDA); and sulfomethyl-N,N-diacetic acid (SMDA) and alkali metal salts or ammonium salts thereof.

23. The automatic dishwashing detergent composition according to claim 22 comprising an amino acid based builder selected from the group consisting of (methyl-glycine-diacetic acid), and salts and derivatives thereof; (glutamic-N,N-diacetic acid) and salts and derivatives thereof; and aspartic acid-N,N-diacetic acid (ASDA).

24. The automatic dishwashing detergent composition according to claim 22 comprising 5% to 50% by weight of said amino acid based builder.

25. The automatic dishwashing detergent composition according to claim 24 comprising 10% to 45% by weight of said amino acid based builder.

\* \* \* \* \*